



Armed Forces College of Medicine AFCM



Cardiovascular regulation-3

‘Blood Flow Regulation’

By

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INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student should be able to:

- ✓ **Explain local regulation of blood flow**
- ✓ **Explain the significance of Autoregulation (myogenic and metabolic)**
- ✓ **Compare short term and long-term regulation of blood flow**
- ✓ **Compare active and reactive hyperemia**
- ✓ **Compare the role of endothelium and platelets in local regulation of blood flow**
- ✓ **Outline the effects of circulating hormones in blood flow regulation**
- ✓ **Evaluate the role of vasoconstrictor hormones in regulation of blood flow**
- ✓ **Evaluate the role of vasodilator hormones in regulation of blood flow**
- ✓ **Explain the role of autonomic nervous system in controlling the blood**

Mechanisms of blood flow regulation



Local regulatory mechanisms

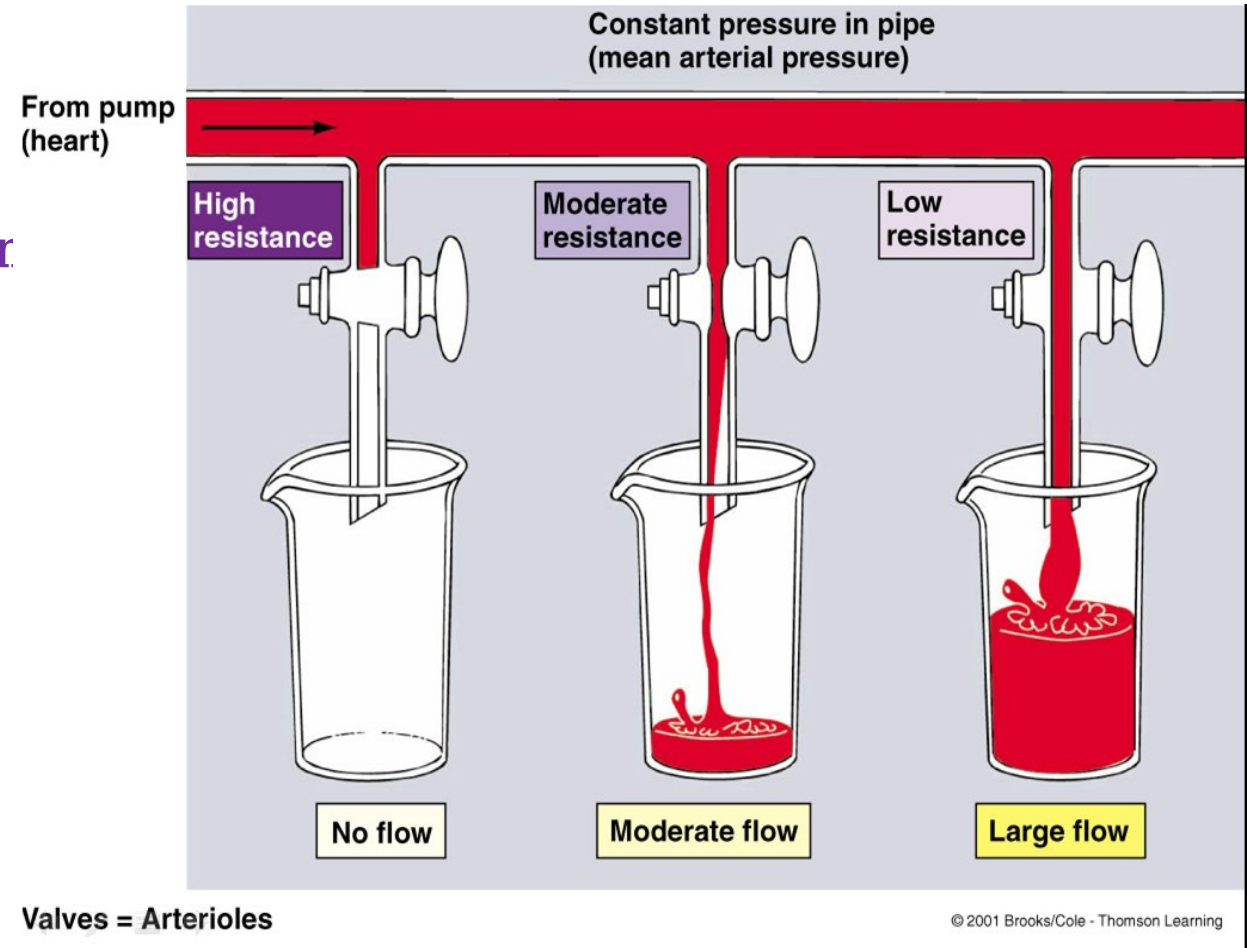
- ✓ Autoregulation
- ✓ Locally produced vasoactive substances

Systemically circulating vasoactive substances

- ✓ Vasoconstrictor hormones
- ✓ Vasodilator hormones

Nervous regulation

- ✓ Sympathetic nervous system
- ✓ Parasympathetic nervous system



Local regulatory mechanisms



I) Autoregulation

= The ability of a tissue to automatically adjust its own blood flow to match its metabolic demand for supply of O₂ & nutrients and removal of wastes

- o **Myogenic**
- o **Metabolic**

II) Local vasoactive substances

- o **NO**
- o **Prostacyclin**
- o **Endothelins**
- o **Thromboxane A₂**

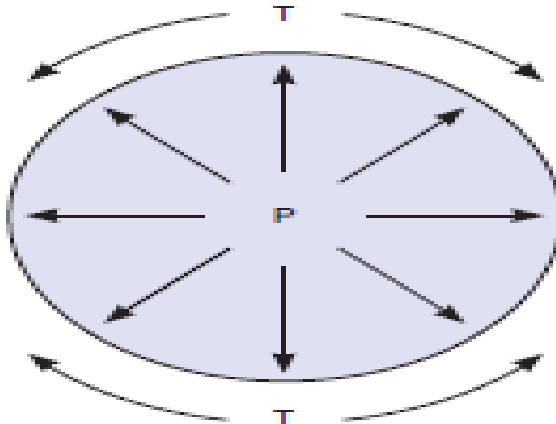
I) Autoregulation



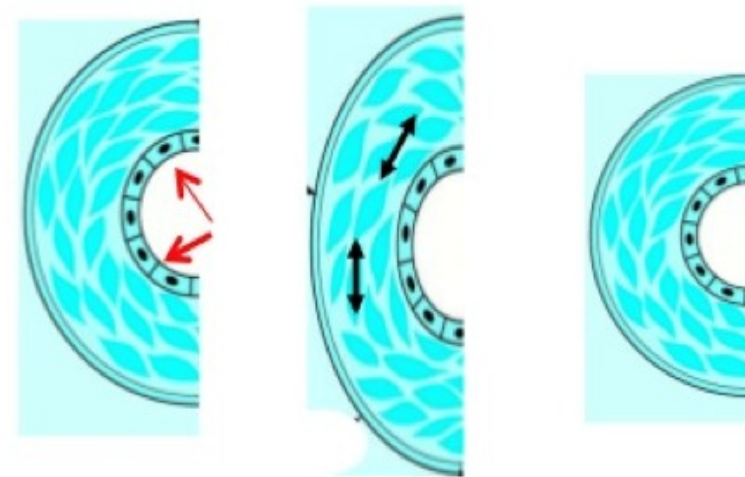
a) Myogenic autoregulation:

Mechanism: Achieved by the intrinsic contractile response of vascular smooth muscle to stretch

'As the pressure rises, the blood vessels distended and the vascular smooth m



$$T = P \times R$$



Incr. B.P.

→ Incr. stretch of muscles

→ stretched muscles contract → smaller radius → greater resistance

I) Autoregulation

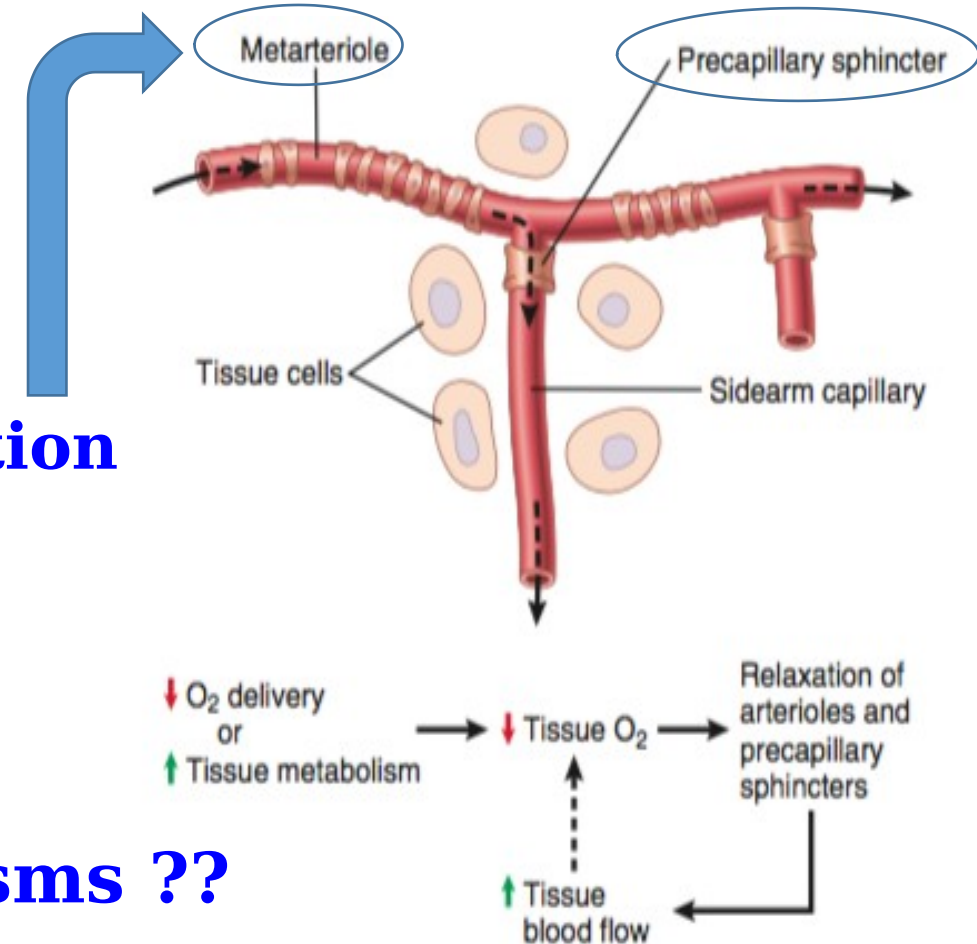


b) Metabolic autoregulation

Metabolites that cause vasodilation

- ✓ Decrease in oxygen tension
- ✓ Increases in CO₂ tension
- ✓ Acidosis
- ✓ Rise in temperature in active tissues
- ✓ K⁺ and lactate in skeletal muscle
- ✓ Histamine in injured tissues
- ✓ Adenosine in cardiac muscle

Relaxation



Short-term & Long-term mechanisms ??

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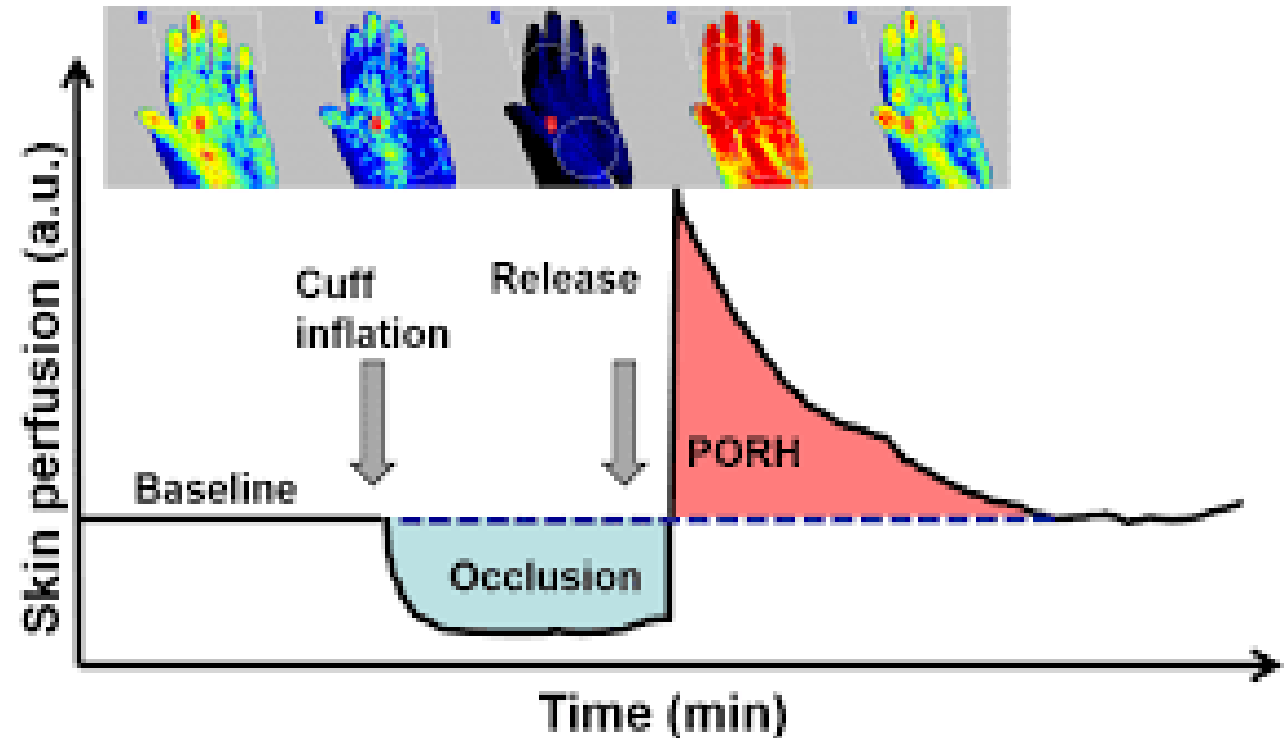
Short- term **Metabolic** autoregulation



□ *Reactive hyperemia*

➤ *The block of blood supply to the tissue causes the nutrients (including O_2) to be consumed and the vasodilator metabolites to accumulate*

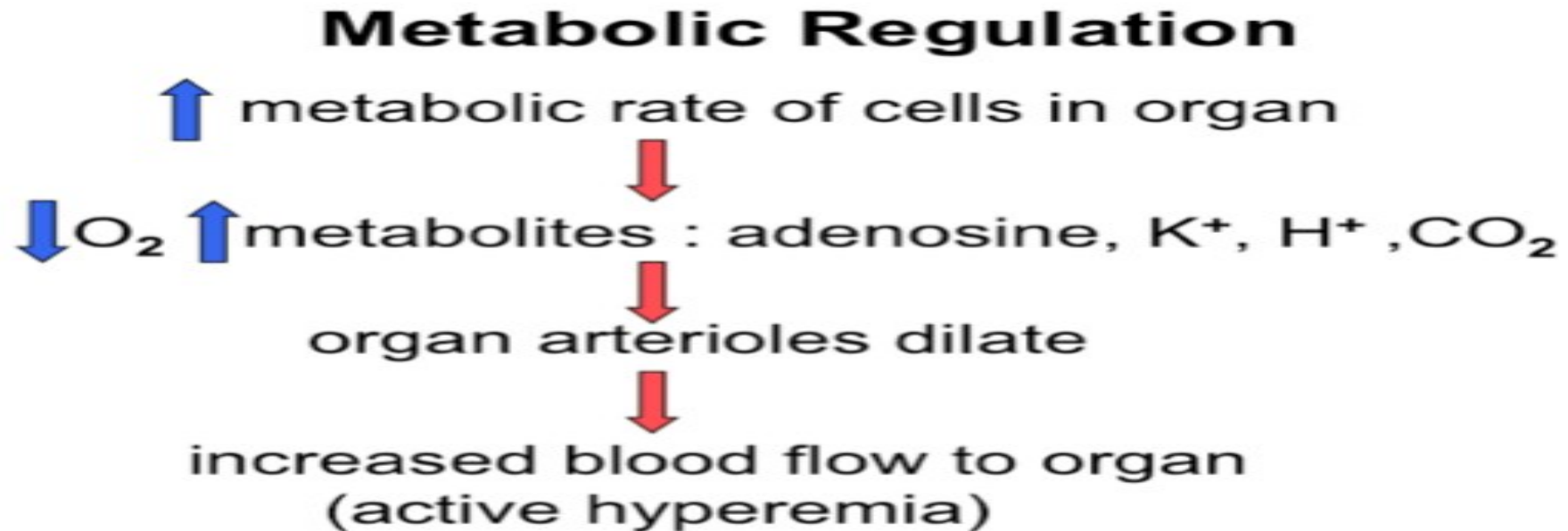
➤ *When the block is released, more blood will flow to the dilated metarterioles and precapillary sphincters*



Short- term **Metabolic** autoregulation



□ *Active hyperemia*



Important in :

Heart (very sensitive to low O₂ and adenosine)
Brain (very sensitive to high CO₂)
Skeletal muscle

Long- term **Metabolic** autoregulation

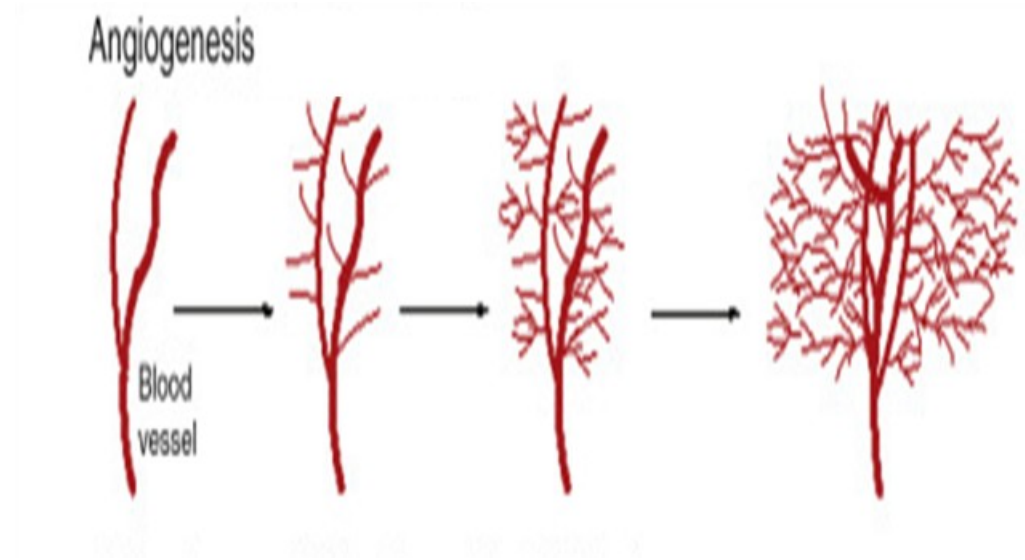


Angiogenesis

= *Long acting mechanisms that work over a period of weeks or months*

✓ **Hypoxia will stimulate production of certain factors causing angiogenesis**

(increased tissue vascularity and the development of collaterals)



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Local regulatory mechanisms



I) Autoregulation

- o Myogenic
- o Metabolic

II) Local vasoactive substances

- o NO
- o Prostacyclin
- o Endothelins
- o Thromboxane
- A2



Secreted by the endothelium or the platelets

II) Local Vasoactive Substances



VC

Endothelins (1,2

- ✓ Vascular tone regulation
- ✓ Veins > arteries
- ✓ Paracrine

Thromboxane A₂

- ✓ From platelets
- ✓ + + Platelet aggregation

VD

Nitric Oxide

- ✓ Nitric oxide synthase
- ✓ Needed for normal ABP
- ✓ Other vasodilators
- ++ its release

Prostacyclin

- ✓ - -
- Platelets**

Mechanisms of blood flow regulation



Local regulatory mechanisms

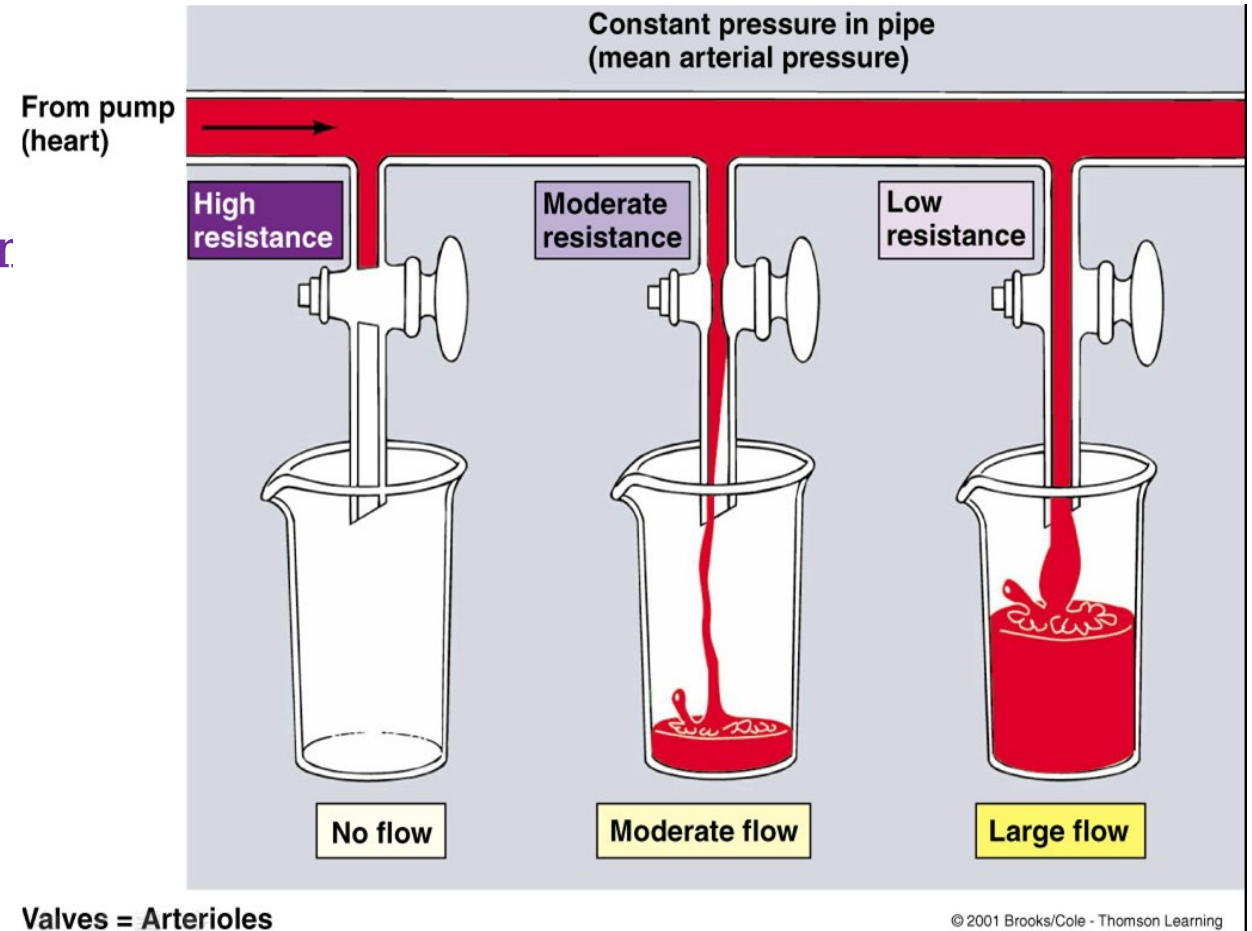
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B) Systemic regulation of blood flow



1) Hormonal control

VC

Norepinephrine & Epinephrine

- ✓ *++ Heart*
- ✓ *VC of all vascular beds*

Antidiuretic hormone

- ✓ *Potent VC of systemic and renal beds*
- ✓ *Decrease urine formation*
- ✓ *Stimulated by hypovolemia & increased osmotic pressure*

Renin Angiotensin System

VD

Atrial natriuretic peptide

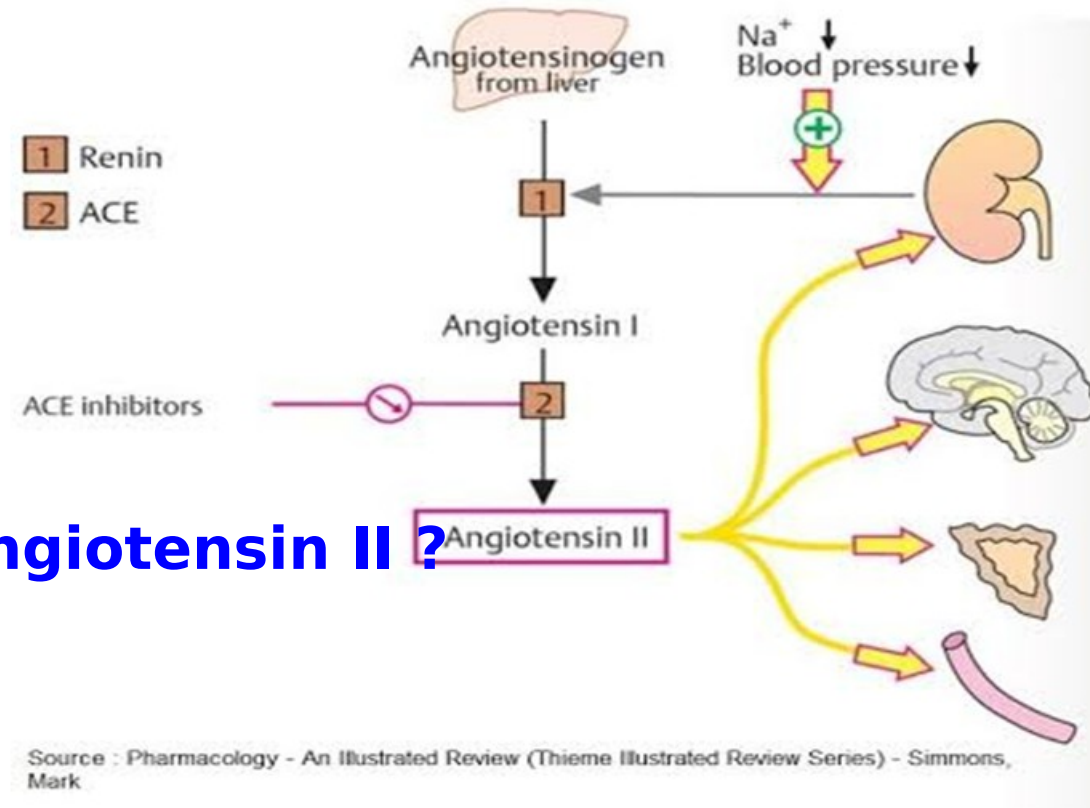
Kinins

B) Systemic regulation of blood flow



Vasoconstrictor Hormones:

RAS



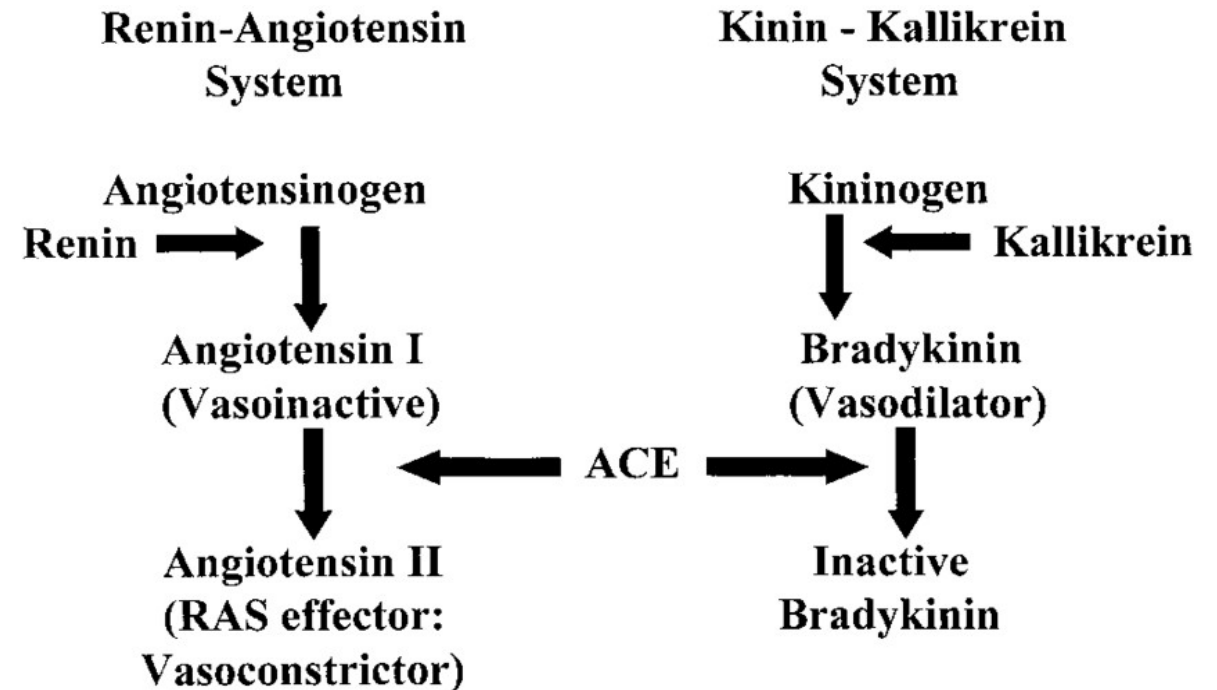
What are actions of Angiotensin II ?

B) Systemic regulation of blood flow



Vasodilator Hormones: **Kinins**

- ✓ ++ EDRF (**NO**) → lowering BP
- ✓ ↑ Capillary permeability & attract leucocytes
- ✓ ↑ Blood flow in certain tissues when they are actively secreting e.g. *sweat glands, salivary glands and exocrine portion of pancreas*

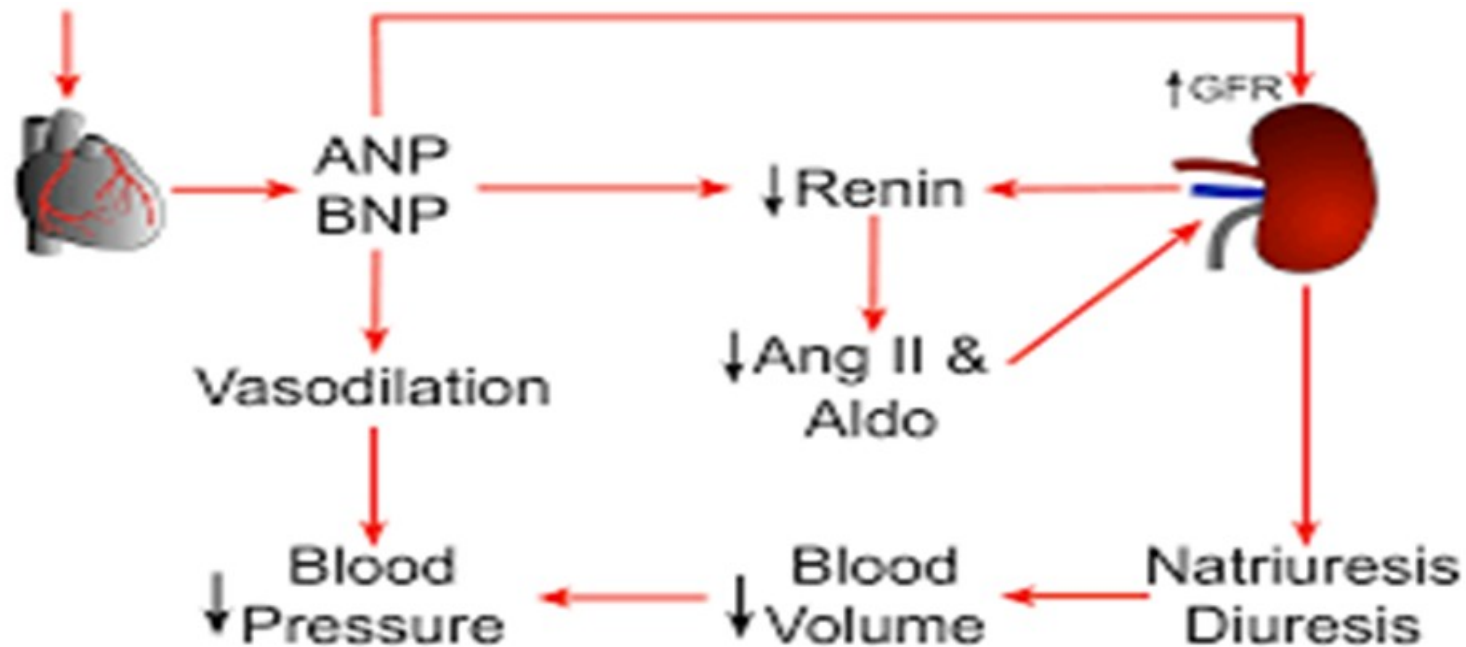


B) Systemic regulation of blood flow



Released in
response to ++
blood volume

Vasodilator Hormones: ANP



✓ **Vasodilator of capacitance & resistance vessels**

✓ **Natriuretic & diuretic**

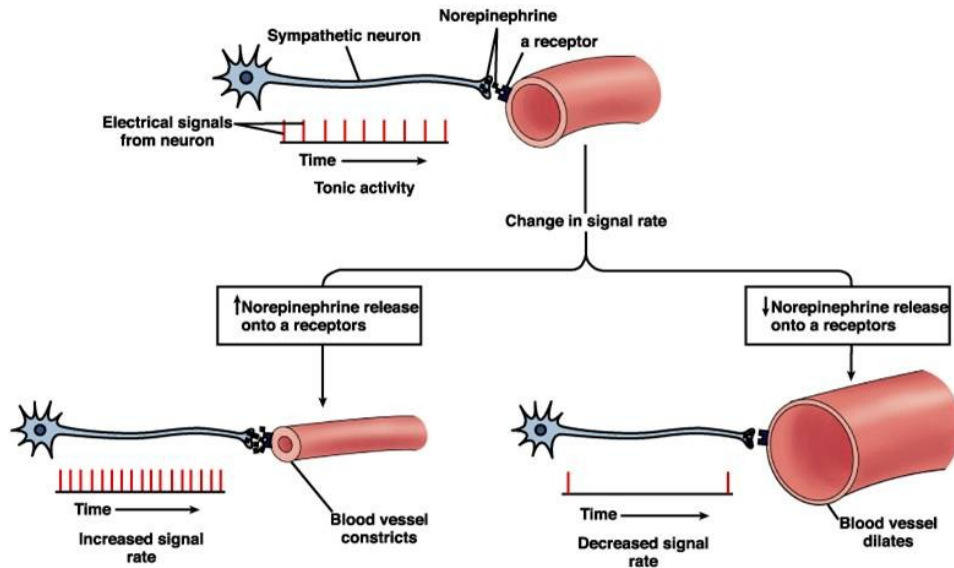
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B) Systemic regulation



2) Neural Control

Arterioles are under resting sympathetic tone



Sympathetic Noradrenergic neurons

VC
Vasomotor tone

VD happen by decreasing sympathetic activity

Cholinergic fibers

Release acetyl choline
Little effect on resistance vessel

Cholinergic fibers to skeletal muscle, sweat glands & erectile tissue

Lecture Quiz



- 1) **Which of the following is NOT an action of angiotensin II?**
- a. Aldosterone secretion
 - b. Vasodilation
 - c. Salt retention
 - d. Sympathetic activation
 - e. ADH secretion
- 2) **Which of the following is endothelial vasodilator substance?**
- f. Norepinephrine
 - g. ADH
 - h. Angiotensin II
 - i. NO
 - j. Endothelins

SUGGESTED TEXTBOOKS



1. Guyton and Hall. *Text book of Medical Physiology, 13th Edition*

2. Ganong's *Review of Medical Physiology, 25th Edition*

3. Sherwood. *Human Physiology From Cells to*

